FORM PTO-1390 U.S. Department of Commerce Patent and Trademark Office

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

Attorney's Docket No.: 1137-782A

U.S. Application No. (if known, see 37 CFR 1.5): 09/355732

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP/97/04644	December 16, 1997	December 16, 1997

TITLE OF INVENTION
METHOD OF RADIO CHANNEL ASSIGNMENT FOR RADIO COMMUNICATION

APPLICANT(S) FOR DO/EO/US
Kazuhiko MARUYAMA

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has **NOT** expired.
   d. [X] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

ITEMS 11. TO 16. below concern other document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [X] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A **FIRST** preliminary amendment.
    [ ] A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information:
    - Copy of International Search Report & references cited therein (3)

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY DOCKET NO.
09/355732	PCT/JP97/04644	1137-782A

17.		CALCULATIONS	PTO USE ONLY
[X]	The following fees are submitted:		
	Basic National Fee (37 CFR 1.492)(a)(1)-(5):		
	Search Report has been prepared by the EPO or JPO	$ 840.00	
	International preliminary examination fee paid to USPTO (37 CFR 1.482)	$ 670.00	
	No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))	$ 760.00	
	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$ 970.00	
	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)	$ 96.00	
	ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840.00	
	Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	15 -20 =	0	X $18.00	$	
Independent Claims	4 - 3 =	1	X $78.00	$ 78.00	
Multiple dependent claim(s) (if applicable)			+ $260.00	$	
			TOTAL OF ABOVE CALCULATIONS =	$ 918.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
			SUBTOTAL =	$	
Processing fee of $130.00 for furnishing the English translation later [ ] 20 [ ] 30 than months from the earliest claimed priority date (37 CFR 1.492(f)).			+	$	
			TOTAL NATIONAL FEE =	$ 918.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property			+	$ 40.00	
			TOTAL FEES ENCLOSED =	$ 958.00	
				Amount to be refunded	$
				charged	$

a. [X] Checks in the amount of $918 & $40 to cover the above fees are enclosed.

b. [ ] Please charge my Deposit Account No. 02-2135 in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-2135. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
Vincent M. DeLuca
Rothwell, Figg, Ernst & Kurz
555 13th St., N.W.
Washington, D.C. 20004
Phone: 202/783-6040

Vincent M DeLuca
Signature

Vincent M. DeLuca
Name

32,408
Registration Number

1137-782A
VMD:cjk

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)	
	)	
Kazuhiko MARUYAMA	)	
	)	
Serial No.	)	
	)	
Filed: (Concurrently Herewith)	)	August 3, 1999
	)	
For: METHOD OF RADIO CHANNEL ASSIGNMENT FOR RADIO COMMUNICATION	)	

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Please amend the above-identified application as follows:

In the Claims:

Claim 11, line 2, delete "any one of claims 1 to 10" and substitute therefor --claim 1--.

Claim 12, line 2, delete "any one of claims 1 to 10" and substitute therefor --claim 1--.

REMARKS

The present Preliminary Amendment is being made in order to eliminate the multiple dependent claims from the application. No new matter is added by this Amendment and, accordingly, entry thereof is respectfully requested.

Respectfully submitted,

ROTHWELL, FIGG, ERNST & KURZ, p.c.

By Vincent M DeLuca

Vincent M. DeLuca
Attorney for Applicant
Registration No. 32,408

555 Thirteenth Street, N.W.
Suite 701 East Tower
Washington, D.C. 20004
Telephone: (202)783-6040

SPECIFICATION

METHOD OF RADIO CHANNEL ASSIGNMENT FOR RADIO COMMUNICATION

TECHNICAL FIELD

The present invention relates to a method of radio channel assignment for radio communications between one base station and a plurality of radio terminals which are in its radio zone, such as portable radiotelephones, cordless telephones and personal handy phones (PHS).

BACKGROUND ART

Fig. 1 is a diagrammatic showing of the configuration of a conventional communication network system, in which base stations 1 and 2 of radio zones respectively E1 and E2 are interconnected through a public switched telephone network 3. Radio terminals A to F in radio zone E1 communicate with the base station 1, for example, by frequency division multiple access (FDMA) or time division multiple access (TDMA).

In this instance, when radio terminals A to F are used as ordinary telephones, the amount of data for communication (hereafter communication data) is constant, and hence they need only to be assigned a radio channel of a fixed channel capacity. However during data communication, the amount of communication data increases or decreases according to the state of access. When the amount of communication data increases, if such channel capacity factors as the number of channels and slots and the frequency bandwidth remain unchanged despite an increased amount of data, resources run short which results in a

failure to achieve a satisfactory transmission speed. On the contrary, when the amount of communication data decreases, the degree of unused resources increases and radio channels are not effectively used.

To overcome the above drawbacks, a method has been proposed which employs small-capacity and large-capacity radio channels each provided separately and selectively switches them according to the amount of communication data as disclosed, for example, in Pat. Appln. Laid-Open Gazette No. 97824/96.

However, when the number of communication terminals that use only the small-capacity radio channels is larger than the total number of small-capacity radio channels, some of the communication terminals cannot be assigned radio channels. Furthermore the assignment of large-capacity radio channels to such communication terminals will inevitably give arise to a problem of ineffective use of radio channels.

The present invention is intended to solve the above problem, and has the object of increasing the speed of data communication and reducing waste in the use of radio channels through the effective utilization of a limited number of channels on the basis of changing the number of channels, the number of slots, the frequency bandwidth, or similar channel factors in accordance with the amount of communication data or the rate of change in the amount of communication data per unit time.

DISCLOSURE OF THE INVENTION

According to an aspect of the present invention, in a radio channel assignment method for radio communication between a base station and a plurality of radio terminals in its radio zone, it is possible to speed up data communication and reduce inefficient use

of radio channels through effective use of a limited number of radio channels by increasing or decreasing the number of radio channels in accordance with the amount of communication data between the base station and each radio terminal.

According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by decreasing the number of radio channels when the amount of communication data is smaller than a preset reference value, and by assigning a plurality of radio channels to the radio terminal concerned when the amount of communication data is larger than a preset reference value.

According to another aspect of the present invention, it is possible to speed up data communication by assigning a plurality of consecutive available radio channels to the radio terminal concerned when the amount of communication data is larger than a preset reference value.

According to another aspect of the present invention, it is possible to speed up the data communication by sending a radio channel assignment message from the base station to the radio terminal concerned in order to change the radio channel assigned thereto to a plurality of consecutive available radio channels.

According to another aspect of the present invention, it is possible to speed up the data communication by sending a radio channel assignment message from the radio terminal concerned to the base station in order to change the radio channel assigned so far to a plurality of consecutive available radio channels.

According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio

channels by assigning with a new radio channel to a radio terminal assigned a radio channel which is one of a plurality of consecutive available radio channels required for another radio terminal.

According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by sending a radio channel assignment request message from the base station to a radio terminal assigned with a radio channel which is one of a plurality of consecutive available radio channels required for another radio terminal and by assigning a different radio channel to the radio terminal concerned.

According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by sending a radio channel assignment request message from the a radio terminal concerned to the base station, by sending thereto a radio channel assignment message to the radio terminal assigned with a radio channel required by another radio terminal, and by assigning a different radio channel to the radio terminal concerned.

According to another aspect of the present invention, it is possible to increase the number of terminals that can be simultaneously connected to the base station, by decreasing the number of channels assigned per terminal through effective utilization of a limited number of radio channels. This is achieved by decreasing the number of radio channels assigned to a radio terminal to make one of them unassigned when a radio terminal is newly connected to the base station.

According to another aspect of the present invention, it is possible to reduce inefficient use of radio channels through effective

a radio communication system in which a plurality of radio terminals communicate with one base station by time division multiple access (TDMA); Fig. 10 is an explanatory diagram of variation in radio channel assignment when the amount of communication data is larger than a preset threshold; Fig. 11 is an explanatory diagram of variation in radio channel assignment when the amount of communication data is smaller than the preset threshold; Fig. 12 is an explanatory diagram of variation in radio channel assignment when a terminal C, which uses a plurality of slots, hops; Fig. 13 is an explanatory diagram of variation in radio channel assignment when a terminal adjacent the terminal C, which uses a plurality of slots, hops; Fig. 14 is an explanatory diagram of variation in radio channel assignment for decreasing the number of slots assigned to channel C down to one when no slots are available; Fig. 15 is an explanatory diagram of variation in radio channel assignment for assigning one of the slots assigned to the terminal C to another terminal when no slots are available; Fig. 16 is an explanatory diagram of variation in radio channel assignment when fragmented channels are gathered together; Fig. 17 is a diagram showing a sequence for the radio terminal side to request the base station side to change the radio channel assignment; and Fig. 18 is a diagram showing a sequence for the base station side to request the radio terminal side to change the radio channel assignment.

BEST MODE FOR CARRYING OUT THE INVENTION

To facilitate a better understanding of the present invention, a detailed description will be given, with reference to the accompanying drawings, of the best mode for carrying out the invention.

of stored data per unit time.

According to still another aspect of the present invention, in a radio channel assignment method for radio communication between a base station and a plurality of radio terminals staying in the radio zone of the base station, it is possible to speed up the data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by sending, upon occurrence of a hand-over, the number of assigned channels to a base station with which the radio terminal newly communicates.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram illustrating a communication network system; Fig. 2 is a block diagram depicting the configuration of a radio communication system in which a plurality of radio terminals communicate with one base station by frequency division multiple access (FDMA); Fig. 3 is an explanatory diagram of variation in radio channel assignment when the amount of communication data is larger than a preset threshold; Fig. 4 is an explanatory diagram of the variation in the radio channel assignment when the amount of communication data is smaller than the preset threshold; Fig. 5 is an explanatory diagram of the variation in radio channel assignment when a terminal C, which uses a plurality of channels, hops; Fig. 6 is an explanatory diagram of variation in radio channel assignment when a terminal adjacent the terminal C, which uses a plurality of channels, hops; Fig. 7 is an explanatory diagram of variation in radio channel assignment in the absence of available channels; Fig. 8 is an explanatory diagram of variation in radio channel assignment when fragmented channels are gathered together; Fig. 9 is a block diagram illustrating the configuration of

utilization of a limited number of radio channels by assigning a radio channel, made unassigned by changing the radio channel assignment, to a radio terminal required to carry out communication over a plurality of radio channels.

According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by providing frequency division multiple access channels between the radio terminals and the base station.

According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by the provision of time division multiple access channels between the radio terminals and the base station.

According to another aspect of the present invention, in a radio channel assignment method for radio communications between a base station and a plurality of radio terminals in its radio zone, it is possible to speed up the data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by determining the number of radio channels to be assigned, by the base station, in accordance with the rate of change of the amount of stored data per unit time.

According to another aspect of the present invention, in a radio channel assignment method for radio communications between a base station and a plurality of radio terminals in the radio zone of the base station, it is possible to speed up the data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by determining the number of radio channels to be assigned, by each radio terminal, in accordance with the rate of change of the amount

EMBODIMENT 1

Fig. 2 is a block diagram depicting a radio communication system according to Embodiment 1 of the present invention in which a plurality of radio terminals A (5A) to F (5F) communicate with one base station 1 by frequency division multiple access (FDMA).

The radio terminals A (5A) to F (5F) are each composed of: a buffer 11 for storing data to be sent; an amount-of-data monitor 12 for detecting the amount of data stored in the buffer 11, for example, in terms of software under program control; a controller 13 for controlling the radio terminal; a modulator 14 which performs modulation (changing the bandwidth) as determined by the controller 13; a transmitter 15; a demodulator 16; and a receiver 17.

The base station 1 is provided with: individual base stations 1A to 1F corresponding to the radio terminals A (5A) to F (5F), respectively; a controller 4 for controlling the individual base stations 1A to 1F; and a channel assignment monitor 5 for monitoring the channel assignment of the base station 1.

The individual base stations 1A to 1F are each made up of: a receiver 21; a demodulator 22; a buffer 23 for storing received data; an amount-of-data monitor 24 for detecting the amount of data stored in the buffer 23, for example, in terms of software under program control; a modulator 25; and a transmitter 26.

Next, the operation of this embodiment will be described below.

The radio terminal A (5A): stores communication data in the buffer 11; monitors the amount of data stored therein by the amount-of-data monitor 12; decides a required channel capacity for communication, by the controller 13 based on the result of

monitoring; and sends a channel capacity change request message based on the decision result to the individual base station 1A via the modulator 14 from the transmitter 15.

The individual base station 1A: demodulates the signal received by the receiver 21 with the demodulator 22; checks the demodulated data by the controller 4; determines whether or not to respond to an inquiry of the radio channel assignment request message from the radio terminal A (5A), based on the result of monitoring by the monitor 5; and sends the determination result from the controller 4 to the radio terminal A (5A) via the modulator 25 and the transmitter 26 of the individual base station 1A.

Based on a radio channel assignment permission message sent from the individual base station 1A, the radio terminal A (5A) sends communication data from the buffer 11 by the transmitter 15 via the modulator 15 to the individual base station 1A.

A description will be given below of varying the radio channel in response to a change in the amount of communication data.

1. When the amount of communication data is larger than a preset threshold:

When a channel M+1 is set for the radio terminal A (5A) as depicted in Fig. 3(a), if the amount of communication data exceeds the channel capacity of the channel M+1, the radio terminal A (5A) requests the individual base station 1A to use, for example, channels M and M+2 adjacent the channel M+1 as shown in Fig. 3(b). On receiving permission from the individual base station 1, the radio terminal A (5A) sets the three adjoining channels for its use. Thus, even if the amount of communication data increases, no increase will be caused in the amount communication time.

2. When the amount of communication data is smaller than a

preset threshold:

When three channels M through M+2 are set as radio channels for the radio terminal A (5A) as depicted in Fig. 4(a), if the amount of communication data becomes smaller than the channel capacity of the channel M+1, the radio terminal A (5A) sends, to the individual base station 1A, a radio channel assignment request message to use only the channel M+1 as shown in Fig. 4(b). After receiving permission from the individual base station 1A, the radio terminal uses that channel alone. Thus, even if the amount of communication data decreases, it is possible to continue communication without wasting channel capacity.

3. When a radio terminal C (5C not shown) that uses a plurality of channels hops:

When the radio terminals A (5A) through D (5D) are assigned the channels M through M+3 as shown Fig. 5(a), if the amount of communication data from the radio terminal C (5C) becomes larger than the channel capacity of the channel M+2, the radio terminal C sends a channel assignment request message to the individual base station 1C (not shown) as depicted in Fig. 3(b). Upon receiving the channel assignment request message, the individual base station 1C requests a channel assignment from the controller 4. Based on the channel assignment status stored in the channel assignment monitor 5, the controller 4 posts a plurality of consecutive channels N, N+1 and N+2 to the individual base station 1C, which, in turn, sends a channel assignment permission message to the radio terminal C to permit the use of the channels N, N+1 and N+2. Upon receiving the permission from the individual base station 1C, the radio terminal C sets the three channels for its use. Thus, even if the amount of communication data increases, it is possible to continue communication without

affecting the adjoining channels and without causing an increase in the amount of communication time.

4. When a radio terminal adjacent the radio terminal C (5C) that uses a plurality of channels hops:

When the channels M through M+3 are set as radio channels for the radio terminals A (5A) through D (5D) as depicted in Fig. 6(a), if the amount of communication data from the radio terminal C (5C) becomes larger than the channel capacity of the channel M+2, the radio terminal C (5C) sends a channel assignment request message to the individual base station 1C (not shown) as depicted in Fig. 6(b). Upon receiving the channel assignment request message, the individual base station 1C requests a channel assignment from the controller 4. Based on the channel assignment status stored in the channel assignment monitor 5, the controller 4 instructs the individual base stations 1B and 1D to use channels N and N+1. The individual base stations 1B and 1D post, by a channel assignment permission message, to the radio terminals B and D the assignment thereto of the channels N and N+, respectively. The individual base station 1C posts, by a channel assignment permission message, to the radio terminal C the assignment thereto of the channels M, M+1 and M+2. Thus, even if the amount of communication data increases, it is possible to continue communication without affecting the adjoining channels and without causing an increase in the amount of communication time.

5. When no channels are available:

In the case where all the channels are set for the radio terminals A (5A) through f (5F) and no channels are available as depicted in Fig. 7(A), if a radio terminal G (5G, not shown) sends a radio channel assignment message to an individual base station

1G, then the controller 4 reduces the three channels set for the radio terminal C (5C) to one channel, and sets the one available channel N+1 as a radio terminal G (5G) and the other channel N+2 as an unassigned channel as shown in Fig. 7(b). As a result, although the transmission speed of the radio terminal C (5C) decreases, the radio terminal G (5G) can carry out communication.

6. Fragmented unassigned channels are gathered together:

When the channels M, M+2, N+1 and N+3 are set to the radio terminals A (5A), B (5B), C (5C) and D (5D), respectively, as shown in Fig. 8(a), the individual base stations 1B and 1D (not shown) send radio channel assignment messages to the radio terminal B (5B) and D (5D) to assign the channels M+1 and M+3, respectively, as depicted in Fig. 8(b). As a result, the unassigned channels can be gathered together without inhibiting communication.

EMBODIMENT 2

Fig. 9 is a block diagram illustrating the configuration of a radio communication system according to Embodiment 2 of the present invention in which a plurality of radio terminals communicate through a single base station by time division multiple access (TDMA). In Fig. 9, reference characters A (51A) to F (51F) denote radio terminals, and 52 a base station. The radio terminals A (51A) to F (51F) are each composed of: a buffer 61 for storing data to send; an amount-of-data monitor 62 for detecting the amount of data stored in the buffer 61, for example, in terms of software under program control; a controller 63 for controlling the radio terminal; a modulator 64; a transmitter 65; a demodulator 66; a receiver 67; a time-division transmitter 68 for determining transmission timing; and a time-division receiver 69 for

determining reception timing.

The base station 52 comprises: individual base stations 52A to 52F correspond to the radio terminals A (51A) to F (51F), respectively; a controller 53 for controlling the individual base stations 52A to 52F; and a channel assignment monitor 54 for monitoring the channel assignment of the base station 52.

The individual base stations 52A to 52F are each made up of: a receiver 71; a demodulator 72; a buffer 73 for storing received data; an amount-of-data monitor 74 for detecting the amount of data stored in the buffer 73, for example, in terms of software under program control; a modulator 75; a transmitter 76; time-division receiver 77 for determining reception timing; and a time-division transmitter 78 for determining transmission timing.

Next, the operation of this embodiment will be described below.

The radio terminal A (51A): stores communication data in the buffer 61; monitors the amount of data stored therein by the amount-of-data monitor 62; decides a required channel capacity for communication, by the controller 63 based on the result of monitoring; and sends a channel capacity change request message based on the decision result to the base station 52 via the modulator 64 from the transmitter 65 at the transmission timing provided from the time-division transmitter 69.

The individual base station 52A uses the demodulator 22 to demodulate the signal received by the receiver 71 at the reception timing provided from the time-division receiver 77. It checks the demodulated data by the controller 53, determines whether or not to respond to the radio channel assignment request message from the radio terminal A (51A), based on the result of monitoring by the monitor 54, and sends the determination result from the controller

53 of the base station 52 to the radio terminal A (51A) via the modulator 75 and the transmitter 76 of the individual base station 52A at the timing for transmission provided by the time-division transmitter 78.

The radio terminal A (51A): receives the instruction signal from the individual base station 52A at the reception timing provided by the time-division receiver 67; and sends the communication data, stored in the buffer 61, via the modulator 64 to the base station 52A from the transmitter 65 over the radio channel instructed by the base station 52A.

A description will be given below of the variation in the radio channel with a change in the amount of communication data.

7. When the amount of communication data is larger than a preset threshold:

When a slot S1 of a channel M is set as a radio channel for the radio terminal A (51A) as depicted in Fig. 10(a), if the amount of communication data becomes larger than the channel capacity of the slot S1 of the channel M, the radio terminal A (51A) sends a channel assignment request message to the individual base station 52A as shown in Fig. 10(b). Upon receiving the channel assignment request message, the individual base station 52A requests a channel assignment of the controller 53, and based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts a plurality of consecutive slots S1 to S3 of the channel M to the individual base station 52A; and the individual base station 52A posts the slots S1 to S3 of the channel M to the radio terminal A (51A) by a channel assignment permission message. Upon receiving the permission from the individual base station 52A, the radio terminal A (51A) uses the slots S1 to S3 for communication. Thus, even if the amount of

communication data increases, the time for communication will not increase.

8. When the amount of communication data is smaller than a preset threshold:

When all the slots S1 to S3 of the channel M are set as a radio channel for the radio terminal A (51A) as depicted in Fig. 11(a), if the amount of communication data becomes smaller than the channel capacity of the slot S1, the radio terminal A (51A) sends a channel assignment request message to the individual base station 52A as shown in Fig. 11(b). Upon receiving the channel assignment request message, the individual base station 52A requests a channel assignment of the controller 53, and based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts the slot S1 of the channel M containing a plurality of consecutive slots to the individual base station 52A; and the individual base station 52A posts the slot S1 the channel M to the radio terminal A (51A) by a channel assignment permission message. Upon receiving the permission from the individual base station 52A, the radio terminal A (51A) uses the slot S1 for communication. Thus, even if the amount of communication data decreases, it is possible to continue communication without wasting channel capacity.

9. When the radio terminal C (51C) that uses a plurality of slots hops:

When all the slots S1, S2 and S3 of the channel M are set as radio channels for the radio terminals A (51A), B (51B) and C (51C) and all slots of the channel M+1 are unassigned as shown Fig. 12(a), the radio terminal C (51C) sends a channel assignment request message to the individual base station 52C (not shown) as depicted in Fig. 12(b) on an increase in the amount of

communication data. Upon receiving the channel assignment request message, the individual base station 52C requests a channel assignment of the controller 53. Based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts a plurality of consecutive slots S1 to S3 of the channel M+1 to the individual base station 52C. The individual base station 52C sends a channel assignment permission message to the radio terminal C (51C) to post thereto the slots S1 to S3 of the channel M+1. Upon receiving the permission from the individual base station 52C, the radio terminal C (51C) sets the three slots S1 to S3 for its use. Thus, even if the amount of communication data increases, it is possible to continue the communication without causing an increase in the amount of time for communication. In this instance, the slot S3 of the channel M becomes unassigned.

10. When a radio terminal adjacent the radio terminal C (51C) that uses a plurality of slots hops:

When all the slots S1, S2 and S3 of the channel M are set as radio channels for the radio terminals A (51A), B (51B) and C (51C) and all the slots of the channel M+1 are unassigned as depicted in Fig. 13(a), the radio terminal C (51C) sends a channel assignment request message to the individual base station 1C (not shown) as depicted in Fig. 13(b). Upon receiving the channel assignment request message, the individual base station 52C requests a channel assignment of the controller 53. Based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts the slots S1 to S3 of the channel M to the individual base station 52C, the slot S1 of the channel M+1 to the individual base station 52A and the slot S2 of the channel M+1 to the individual base station 52B as shown in Fig. 12(b). The

individual base station 52 posts all the slots of the channel M to the radio terminal C (51C) by a channel assignment permission message. The individual base station 52 posts the slot S1 of the channel M+1 to the radio terminal A (51A) by a channel assignment permission message, and the individual base station 52 posts the slot S1 of the channel M+1 to the radio terminal B (51B) by a channel assignment permission message.

The radio terminal C (51C) is set to use all the slots of the channel M. And, the radio terminal A (51A) is set to use the slot S1 of the channel M+1, and the radio terminal B (51B) is set to use the slot S1 of the channel M+1. Thus, even if the amount of communication data increases, it is possible to continue the communication without causing an increase in the amount of time for communication.

11. When no channels are available (when one slot is assigned to the radio terminal C (51C)):

In the case where all the slots S1, S2 and S3 of the channel M are set as radio channels for the radio terminals A (51A), B (51B) and D (51D) and all the slots S1 to S3 of the channel M+1 are set as a radio channel for the radio terminal C (51C) as depicted in Fig. 14(a), if a radio terminal E (51E, not shown) sends a radio channel assignment message, then an individual base station 52E requests a channel assignment of the controller 53 on receipt of the channel assignment request message. Based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts, by channel assignment messages, the slot S1 of the channel M+1 to the individual base station 52C and the slot S2 of the channel M+1 to the individual base station 52E as shown in Fig. 14(b). Accordingly, the individual base station 52C posts the slot S1 of the channel M+1 to the radio terminal C (51C), and the

individual base station 52E posts the slot S2 of the channel M+1 to the radio terminal E (51E). As a result, although the transmission speed of the radio terminal C (5C) decreases, the radio terminal G (5G) can communicate, and the slot S3 of the channel M+1 becomes unassigned.

12. When no channels are available (when slots assigned to the radio terminal C (51C) are assigned to another radio terminal as required):

In the case where all the slots S1, S2 and S3 of the channel M are set as radio channels for the radio terminals A (51A), B (51B) and D (51D) and all the slots S1 to S3 of the channel M+1 are set as a radio channel for the radio terminal C (51C) as depicted in Fig. 15(a), if the radio terminal E (51E) (not shown) sends a radio channel assignment message, then the individual base station 52E having received the channel assignment request message requests a channel assignment of the controller 53, and based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts, by channel assignment messages, the slots S1 and S2 of the channel M+1 to the individual base station 52C and the slot S3 of the channel M+1 to the individual base station 52E as shown in Fig. 15(b). Accordingly, the individual base station 52C posts the slots S1 and S2 of the channel M+1 to the radio terminal C (51C), and the individual base station 52E posts the slot S3 of the channel M+1 to the radio terminal E (51E). As a result, the transmission speed of the radio terminal C (51C) decreases, but the radio terminal E (51E) is allowed to carry out communication.

13. Fragmented unassigned channels are gathered together:

When the slots S1 and S3 of the channel M are set for the radio terminals A (51A) and C (51C) and the slot S2 of the channel

M+1 for the radio terminal B (51B), as shown in Fig. 16(a), the individual base station 52B sends a radio channel assignment message to the radio terminal B (51B) to assign the slot S2 of the channels M as depicted in Fig.16(b). As a result, the unassigned channels can be gathered together without inhibiting communication.

As described above, the assignment of radio channels between radio terminals and a base station can be changed by sending an assignment permission message from the base station side to the radio terminal side in response to a channel assignment change request from the latter to the former as shown in Fig. 17, or by sending an assignment permission message from the radio terminal side to the base station side in response to a channel assignment change request from the latter to the former as depicted in Fig. 18.

EMBODIMENT 3

In the above embodiments channel assignment is varied depending on the amount of communication data. However varying channel assignment with the rate of change of communication data per unit time also allows effective use of a limited number of channels, speeds up data communication and reduces inefficient use of channels.

EMBODIMENT 4

When the radio terminal A moves out of the radio zone of the base station 1 where it has carried out communication so far and into the radio zone of the other base station 2 in Fig. 1 (hand-over), it is possible to speed up data communication and reduce inefficient use of channels by posting the number of radio channels assigned

to the radio terminal A up to that point to the base station upon occurrence of the hand-over.

INDUSTRIAL APPLICABILITY

As described above, the radio channel assignment method according to the present invention changes channel assignments in response to variation in the amount of communication data per unit time. Hence it permits speeding up data communication and reducing inefficient use of channels by effectively using a limited number of channels.

Furthermore, when a hand-over occurs, the number of channels used between the radio terminal concerned and the previous base station is posted to the new base station. In this way, it is possible to speed up data communication between the new base station and the radio terminal and reduce inefficient use of channels.

CLAIMS

1. A radio channel assignment method for radio communications between a base station and a plurality of radio terminals in the radio zone of said base station, characterized in that the number of channels between each said radio terminal and said base station is changed in response to an amount of communication data therebetween.

2. The radio channel assignment method for radio communication according to claim 1, characterized in that when an amount of communication data is smaller than a preset reference value, one radio channel is assigned, and that when the amount of communication data is larger than a preset reference value, a plurality of adjacent radio channels are assigned.

3. The radio channel assignment method for radio communication according to claim 2, characterized in that when an amount of communication data is larger than a preset reference value, a plurality of available radio channels are assigned.

4. The radio channel assignment method for radio communication according to claim 2, characterized in that a base station sends a radio channel assignment message to a radio terminal to assign a plurality of consecutive available radio channels to said radio terminal.

5. The radio channel assignment method for radio communication according to claim 2, characterized in that a radio terminal sends a radio channel assignment message to a base

station to assign a plurality of consecutive available radio channels to said radio terminal.

6. The radio channel assignment method for radio communication according to claim 1, characterized in that a radio terminal which requires a plurality of consecutive available radio channels assigns another radio terminal which has been assigned the channel which it requires to a different radio channel.

7. The radio channel assignment method for radio communication according to claim 6, characterized in that a base station sends a message to a radio terminal assigned a radio channel which is required by another radio terminal so that the radio terminal to which the channel had been assigned is assigned a different radio channel.

8. The radio channel assignment method for radio communication according to claim 6, characterized in that a radio terminal sends a radio channel assignment request message to a base station, and said base station sends a message to another radio terminal which is assigned a radio channel required by the radio terminal in order to assign a different radio channel to the other radio terminal.

9. The radio channel assignment method for radio communication according to claim 1, characterized in that when a radio terminal is added to a radio channel, the number of radio channels assigned to a certain radio terminal is decreased to make one of them unassigned.

10. The radio channel assignment method for radio communication according to claim 2, characterized in that a radio channel made unassigned by changing the radio channel assignment is assigned to a radio terminal required to carry out communication over a plurality of radio channels.

11. The radio channel assignment method for radio communication according to any one of claims 1 to 10, characterized in that radio channels connected between radio terminals and a base station are frequency division multiple access channels.

12. The radio channel assignment method for radio communication according to any one of claims 1 to 10, characterized in that radio channels between radio terminals and a base station are time division multiple access channels.

13. A radio channel assignment method for radio communication between a base station and a plurality of radio terminals in the radio zone of said base station, characterized in that said base station determines a number of channels to be assigned according to the rate of increase of stored data per unit time.

14. A radio channel assignment method for radio communication between a base station and a plurality of radio terminals in the radio zone of said base station, characterized in that said radio terminals each determine a number of channels to be assigned according to the rate of increase of stored data per unit time.

15. A radio channel assignment method for radio communication between a base station and a plurality of radio terminals in the radio zone of said base station, characterized in that said base station transmits, upon occurrence of a hand-over, a number of assigned channels to said base station with which the radio terminal newly communicates.

ABSTRACT

In carrying out radio communication between one base station and a plurality of radio terminals in its radio zone, the number of channels, the number of slots, the frequency band or similar channel factor is changed in accordance with the amount of communication data or the rate of change of the amount of communication data per unit time, by which it is possible to speed up data communication and reduce inefficient use of channels through effective utilization of a limited number of channels.

FIG.1

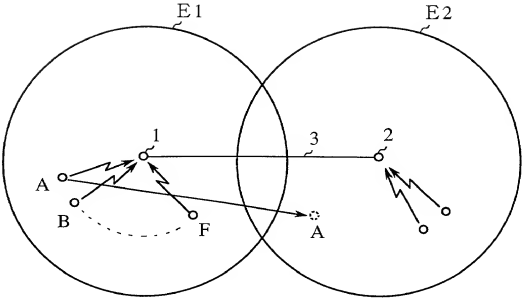


FIG.2

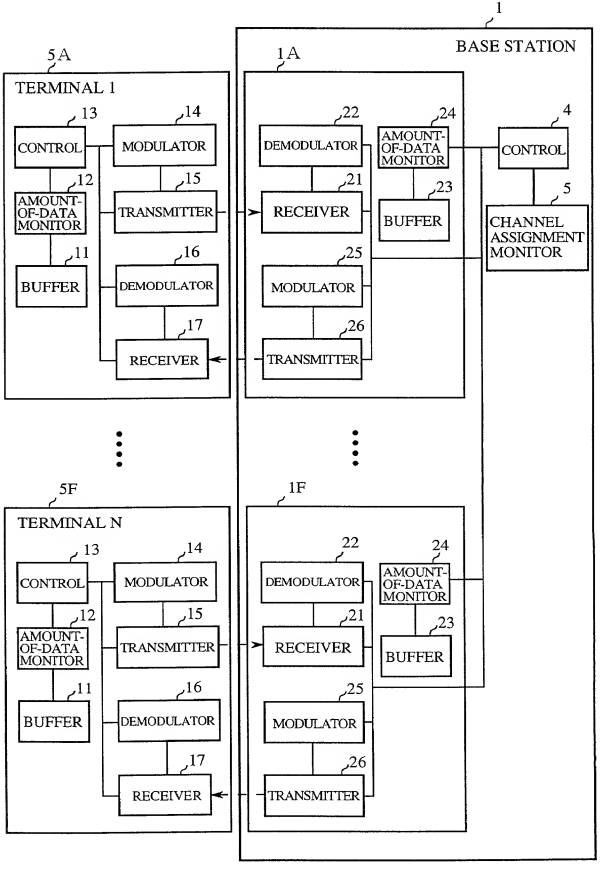

1
BASE STATION
5A
TERMINAL 1
1A
13
CONTROL
14
MODULATOR
12
AMOUNT-OF-DATA MONITOR
15
TRANSMITTER
11
BUFFER
16
DEMODULATOR
17
RECEIVER
22
DEMODULATOR
24
AMOUNT-OF-DATA MONITOR
4
CONTROL
21
RECEIVER
23
BUFFER
5
CHANNEL ASSIGNMENT MONITOR
25
MODULATOR
26
TRANSMITTER
5F
TERMINAL N
1F

FIG.5(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	USED BY TERMINAL D

⋮

CHANNEL N	UNASSIGNED
CHANNEL N+1	UNASSIGNED
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	UNASSIGNED

FIG.5(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	UNASSIGNED
CHANNEL M+3	USED BY TERMINAL D

⋮

CHANNEL N	USED BY TERMINAL C
CHANNEL N+1	USED BY TERMINAL C
CHANNEL N+2	USED BY TERMINAL C
CHANNEL N+3	UNASSIGNED

FIG.3(A)

CHANNEL M	UNASSIGNED
CHANNEL M+1	USED BY TERMINAL A
CHANNEL M+2	UNASSIGNED
CHANNEL M+3	UNASSIGNED

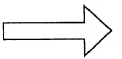


FIG.3(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL A
CHANNEL M+2	USED BY TERMINAL A
CHANNEL M+3	UNASSIGNED

FIG.4(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL A
CHANNEL M+2	USED BY TERMINAL A
CHANNEL M+3	UNASSIGNED

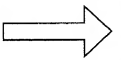
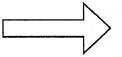


FIG.4(B)

CHANNEL M	UNASSIGNED
CHANNEL M+1	USED BY TERMINAL A
CHANNEL M+2	UNASSIGNED
CHANNEL M+3	UNASSIGNED

FIG.6(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	USED BY TERMINAL D



CHANNEL N	UNASSIGNED
CHANNEL N+1	UNASSIGNED
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	UNASSIGNED

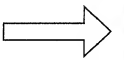


FIG.6(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL C
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	USED BY TERMINAL C

CHANNEL N	USED BY TERMINAL B
CHANNEL N+1	USED BY TERMINAL D
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	UNASSIGNED

FIG.7(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL E
CHANNEL M+3	USED BY TERMINAL D

CHANNEL N	USED BY TERMINAL C
CHANNEL N+1	USED BY TERMINAL C
CHANNEL N+2	USED BY TERMINAL C
CHANNEL N+3	USED BY TERMINAL F

FIG.7(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL E
CHANNEL M+3	USED BY TERMINAL D

CHANNEL N	USED BY TERMINAL C
CHANNEL N+1	USED BY TERMINAL G
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	USED BY TERMINAL F

FIG.8(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	UNASSIGNED
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	UNASSIGNED

⋮

CHANNEL N	UNASSIGNED
CHANNEL N+1	USED BY TERMINAL B
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	USED BY TERMINAL D

FIG.8(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	USED BY TERMINAL D

⋮

CHANNEL N	UNASSIGNED
CHANNEL N+1	UNASSIGNED
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	UNASSIGNED

FIG.9

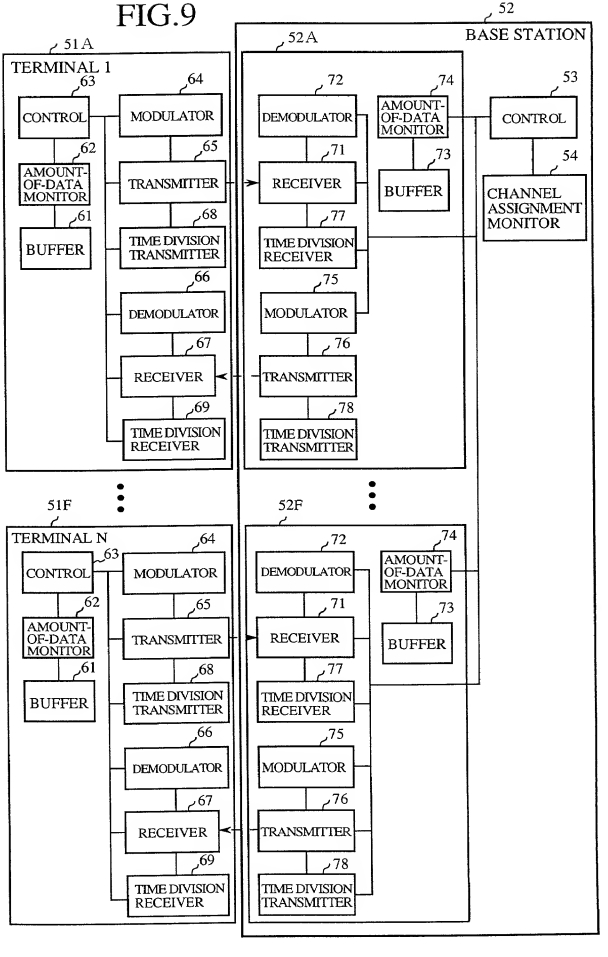

52
BASE STATION
51A
TERMINAL 1
52A
CONTROL
MODULATOR
TRANSMITTER
AMOUNT-OF-DATA MONITOR
BUFFER
TIME DIVISION TRANSMITTER
DEMODULATOR
RECEIVER
TIME DIVISION RECEIVER
DEMODULATOR
RECEIVER
TIME DIVISION RECEIVER
MODULATOR
TRANSMITTER
TIME DIVISION TRANSMITTER
AMOUNT-OF-DATA MONITOR
BUFFER
CONTROL
CHANNEL ASSIGNMENT MONITOR
51F
TERMINAL N
52F
CONTROL
MODULATOR
TRANSMITTER
AMOUNT-OF-DATA MONITOR
BUFFER
TIME DIVISION TRANSMITTER
DEMODULATOR
RECEIVER
TIME DIVISION RECEIVER
DEMODULATOR
RECEIVER
TIME DIVISION RECEIVER
MODULATOR
TRANSMITTER
TIME DIVISION TRANSMITTER
AMOUNT-OF-DATA MONITOR
BUFFER

FIG.10(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	UNASSIGNED	UNASSIGNED	A	UNASSIGNED	UNASSIGNED	A	UNASSIGNED	UNASSIGNED
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.10(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	A	A	A	A	A	A	A	A
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.11(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	A	A	A	A	A	A	A	A
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.11(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	UNASSIGNED	UNASSIGNED	A	UNASSIGNED	UNASSIGNED	A	UNASSIGNED	UNASSIGNED
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.12(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	C	A	B	C	A	B	C
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.12(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	UNASSIGNED	A	B	UNASSIGNED	A	B	UNASSIGNED
CHANNEL M+1	C	C	C	C	C	C	C	C	C

FIG.13(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	C	A	B	C	A	B	C
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.13(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	C	C	C	C	C	C	C	C	C
CHANNEL M+1	A	B	UNASSIGNED	A	B	UNASSIGNED	A	B	UNASSIGNED

FIG.14(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	D	A	B	D	A	B	D
CHANNEL M+1	C	C	C	C	C	C	C	C	C

FIG.14(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	D	A	B	D	A	B	D
CHANNEL M+1	C	E	UNASSIGNED	C	E	UNASSIGNED	C	E	UNASSIGNED

FIG.15(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	D	A	B	D	A	B	D
CHANNEL M+1	C	C	C	C	C	C	C	C	C

FIG.15(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	D	A	B	D	A	B	D
CHANNEL M+1	C	C	E	C	C	E	C	C	E

FIG.16(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	UNASSIGNED	C	A	UNASSIGNED	C	A	UNASSIGNED	C
CHANNEL M+1	UNASSIGNED	B	UNASSIGNED	UNASSIGNED	B	UNASSIGNED	UNASSIGNED	B	UNASSIGNED

FIG.16(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	C	A	B	C	A	B	C
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.17

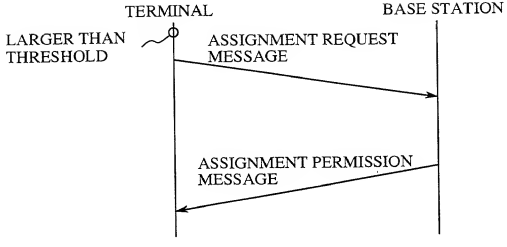
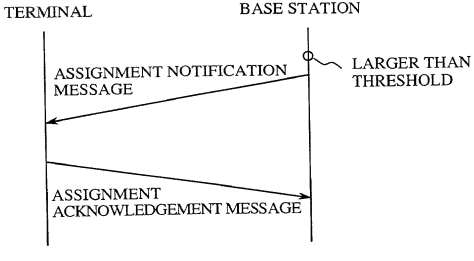

TERMINAL
BASE STATION
LARGER THAN THRESHOLD
ASSIGNMENT REQUEST MESSAGE
ASSIGNMENT PERMISSION MESSAGE

FIG.18


TERMINAL
BASE STATION
ASSIGNMENT NOTIFICATION MESSAGE
LARGER THAN THRESHOLD
ASSIGNMENT ACKNOWLEDGEMENT MESSAGE

Attorney Docket No. _____

Declaration and Power of Attorney
For Patent Application
(Sole/Joint)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought, on the invention entitled "METHOD OF RADIO CHANNEL ASSIGNMENT FOR RADIO COMMUNICATION"

the specification of which *(Check One)*

___ is attached hereto.

X was filed on December 16, 1997 as

[ ] Application Serial No. _____

[X] International Application No. PCT/JP97/04644

and was amended on _____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

			Priority Claimed
(Number)	*(Country)*	*(Day/Month/Year Filed)*	Yes:___ No:___
(Number)	*(Country)*	*(Day/Month/Year Filed)*	Yes:___ No:___
(Number)	*(Country)*	*(Day/Month/Year Filed)*	Yes:___ No:___

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose

material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.)	(Filing Date)	(Status)
(Application Serial No.)	(Filing Date)	(Status)

I or we hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and request that all correspondence about the application be addressed to ROTHWELL, FIGG, ERNST & KURZ, P.C., 555 13th Street, N.W., Washington, D.C 20004

14

G. Franklin Rothwell, Reg. No. 18,125
E. Anthony Figg, Reg. No 27,195
Barbara G. Ernst, Reg. No 30,377
George R. Repper, Reg. No. 31,414
Lawrence G. Norris, Reg. No. 18,034
Bart G. Newland, Reg. No. 31,282
Vincent M. DeLuca, Reg. No. 32,408
Joseph A. Hynds, Reg. No. 34,627
Michael G. Sullivan, Reg. No. 35,377
Jeffrey B. McIntyre, Reg. No. 36,867
Robert J. Jondle, Reg. No. 33,915
Moon Soo Lee, Reg. No. 37,377
Kenneth M. Fagin, Reg. No. 37,615
Stephen B. Parker, Reg. No. 36,631

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Full Name of Sole or First Inventor	Inventor's Signature	Date
Kazuhiko MARUYAMA	Kazuhiko Maruyama	July 20, 1999
Residence Tokyo, Japan		Citizenship Japanese
Post Office Address c/o MITSUBISHI DENKI KABUSHIKI KAISHA, 2-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo 100-8310 Japan		JPX
Full Name of Second Joint Inventor, if any	Inventor's Signature	Date
Residence		Citizenship
Post Office Address		
Full Name of Third Joint Inventor, if any	Inventor's Signature	Date
Residence		Citizenship
Post Office Address		
Full Name of Fourth Joint Inventor, if any	Inventor's Signature	Date
Residence		Citizenship
Post Office Address		